

# PCT

## REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

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International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference  
(if desired) (12 characters maximum) 51044 WO

**Box No. I. TITLE OF INVENTION** Electrical circuit for controlling power supply and motor vehicle built-in device being operably connected to an external power supply

**Box No. II APPLICANT**

☐ This person is also inventor

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

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States

☒ all designated States except  
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of America only

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the Supplemental Box

**Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)**

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☐ Further applicants and/or (further) inventors are indicated on a continuation sheet.

**Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE**

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:

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**Box No. VI PRIORITY CLAIM**

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country	regional application:* regional Office	international application: receiving Office
item (1)				
item (2)				
item (3)				
item (4)				
item (5)				

☐ Further priority claims are indicated in the Supplemental Box.

The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of this international application is the receiving Office) identified above as:

☐ all items   
 ☐ item (1)   
 ☐ item (2)   
 ☐ item (3)   
 ☐ item (4)   
 ☐ item (5)   
 ☐ other, see Supplemental Box

\* Where the earlier application is an ARIPO application, indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed (Rule 4.10(b)(ii)): ....

**Box No. VII INTERNATIONAL SEARCHING AUTHORITY**

Choice of International Searching Authority (ISA) (if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):

ISA / ..SE.....

Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority):

Date (day/month/year)

Number

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**Box No. VIII DECLARATIONS**

The following declarations are contained in Boxes Nos. VIII (i) to (v) (mark the applicable check-boxes below and indicate in the right column the number of each type of declaration):

Number of  
declarations

- |   |  |   |
|---|--|---|
| <input type="checkbox"/> Box No. VIII (i)   | Declaration as to the identity of the inventor   | : |
| <input type="checkbox"/> Box No. VIII (ii)  | Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent             | : |
| <input type="checkbox"/> Box No. VIII (iii) | Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application | : |
| <input type="checkbox"/> Box No. VIII (iv)  | Declaration of inventorship (only for the purposes of the designation of the United States of America)                               | : |
| <input type="checkbox"/> Box No. VIII (v)   | Declaration as to non-prejudicial disclosures or exceptions to lack of novelty   | : |

**Box No. IX CHECK LIST; LANGUAGE OF FILING**

This international application contains:

(a) the following number of sheets in paper form:

request (including declaration sheets) : 4  
 description (excluding sequence listing part) : 15  
 claims : 5  
 abstract : 1  
 drawings : 3

Sub-total number of sheets : 28

sequence listing part of description (actual number of sheets if filed in paper form, whether or not also filed in computer readable form; see (b) below) : \_\_\_\_\_

Total number of sheets : 28

(b) sequence listing part of description filed in computer readable form

- (i) ☐ only (under Section 801(a)(i))  
 (ii) ☐ in addition to being filed in paper form (under Section 801(a)(ii))

Type and number of carriers (diskette, CD-ROM, CD-R or other) on which the sequence listing part is contained (additional copies to be indicated under item 9(ii), in right column): \_\_\_\_\_

This international application is accompanied by the following item(s) (mark the applicable check-boxes below and indicate in right column the number of each item):

1. ☒ fee calculation sheet :  
 2. ☐ original separate power of attorney :  
 3. ☐ original general power of attorney :  
 4. ☐ copy of general power of attorney; reference number, if any: ..... :  
 5. ☐ statement explaining lack of signature :  
 6. ☐ priority document(s) identified in Box No. VI as item(s): ..... :  
 7. ☐ translation of international application into (language): ..... :  
 8. ☐ separate indications concerning deposited microorganism or other biological material :  
 9. ☐ sequence listing in computer readable form (indicate also type and number of carriers (diskette, CD-ROM, CD-R or other )) :  
     (i) ☐ copy submitted for the purposes of international search under Rule 13ter only (and not as part of the international application) :  
     (ii) ☐ (only where check-box (b)(i) or (b)(ii) is marked in left column) additional copies including, where applicable, the copy for the purposes of international search under Rule 13ter :  
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 10. ☐ other (specify): ..... :

Number of items

Figure of the drawings which should accompany the abstract:

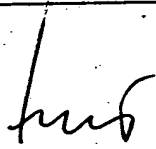
2

Language of filing of the international application:

English

**Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE**

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).



Dr. Thomas Kurig (Patent Attorney)

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1. Date of actual receipt of the purported international application:

3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:

4. Date of timely receipt of the required corrections under PCT Article 11(2):

5. International Searching Authority (if two or more are competent): ISA /

6. ☐ Transmittal of search copy delayed until search fee is paid

2. Drawings:

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Date of receipt of the record copy by the International Bureau:

**Electrical circuit for controlling power supply and motor vehicle built-in device  
being operably connected to an external power supply**

- 5 The present invention relates to an electrical circuit for controlling the power supply of an electrical device. More particularly, the present invention relates to the aforementioned circuit for offering a stand-by mode of the electrical device and operable with wake-up signals and sleep signals causing the switching of the power supply.
- 10 Modern motor vehicles include a large number of electrical devices and electrical units and the number of such electrical devices and units still increases, since buyers of motor vehicle demand these electrical devices and units often in a built-in fashion to provide convenience to the driver of the motor vehicle.
- 15 The electrical devices and units built-in a motor vehicle all have to be energized by the power supply of the motor vehicle typically an accumulator of limited capacity. The accumulator of a motor vehicle is charged during operation of the engine of the motor vehicle so that the power consumption of electrical devices and units of the motor vehicle represents no serious problem while the engine is running. But the power consumption of electrical devices and units
- 20 consuming power from the accumulator during the stop of the engine of the motor vehicle causes a discharging of the accumulator and hence causes a problem. Especially, electrical devices and units operable in a stand-by operation mode have to be designed in a power saving way. The stand-by operation mode allows for example to activate the device or unit being in the stand-by operation mode via a central control unit of the motor vehicle.
- 25 A motor vehicle built-in unit for mobile communication devices is used to couple a mobile communication device such as a mobile phone, a communication handheld and the like, to the further electrical devices and units included in the motor vehicle. The motor vehicle built-in unit allows to couple to an external speaker, e.g. of a car radio, an external microphone, e.g.
- 30 implemented in the dashboard, to an antenna e.g. having a power amplifier, a remote control e.g. having keys for operating functions of the mobile phone, to the electric circuits of the motor vehicle e.g. via a data communication bus of the motor vehicle for remote operating and the like. Typically such a motor vehicle built-in unit for mobile communication devices is operable with stand-by operation mode to be energizable within different situations.

operable switch is conductive in case it is closed and is non-conductive in case it is opened . Further the electrical circuit is provided with at least one wake-up input to receive a wake-up signal and at least one sleep input to receive a sleep signal and the electrical circuit has a bi-stable sub-circuit coupled to the main input and coupled to the first electrical operable switch as well as connected to the at least one wake-up input and to the least one sleep input The bi-stable circuit is operable such that receiving of a wake-up signal results in energizing of the bi-stable sub-circuit and receiving of a sleep signal results in de-energizing thereof. The energized bi-stable sub-circuit effects to close the first electrical operable switch and the corresponding de-energized bi-stable sub-circuit effects to open the first electrical operable switch.

According to an embodiment of the invention, the bi-stable sub-circuit is embodied by a first transistor and a second transistor. The first transistor has an emitter terminal, a collector terminal and a base terminal and is configured with a bridge resistor interconnected between its emitter terminal and its base terminal and a base resistor connected to its base terminal. The second transistor has an emitter terminal, a collector terminal and a base terminal and is configured with a bridge resistor interconnected between its emitter terminal and its base terminal and a base resistor connected to its base terminal. An interposed resistor having a first and a second terminals is interconnected in-between the first and the second transistor.

The first transistor is coupled via its emitter terminal to the main input , via its collector terminal to a first terminal of the interposed resistor and via its base resistor to the collector terminal of the second transistor. The second transistor is coupled via its emitter to ground, via its base resistor to a second terminal of the interposed resistor and via its collector to the base resistor of the first transistor.

The at least one wake-up input is coupled to a first connection line between the base resistor of the first transistor and the collector terminal of the second transistor, both being coupled. The at least one sleep input is coupled to a second connection line between the base resistor of the second transistor and the second terminal of the interposed resistor, both being coupled. The first electrical operable switch being operable with the bi-stable sub-circuit is coupled to the second connection line.

According to an embodiment of the invention, the electrical circuit further implements a third transistor. The third transistor has analogously an emitter terminal, a collector terminal and a base terminal and is analogously configured with a bridge resistor interconnected between its emitter terminal and its base terminal and a base resistor connected to its base terminal. The third transistor is interconnected in-between a connection line coupling the bi-stable sub-circuit and

the first electrical operable switch such that the third transistor is coupled via its base resistor to the second connection line via its collector terminal to the first electrical operable switch and via its emitter terminal to ground.

- 5 According to an embodiment of the invention, the electrical circuit further comprises at least one wake-up transistor. Each wake-up transistor has analogously an emitter terminal, a collector terminal and a base terminal and is analogously configured with a bridge resistor interconnected between its emitter terminal and its base terminal and a base resistor connected to its base terminal. The at least one wake-up transistor is interconnected in-between the at least one wake-up input and the bi-stable sub-circuit such that the at least one wake-up transistor is coupled via its base resistor to the at least one wake-up input, via its emitter terminal to ground and via its collector terminal to the first connection line.

- 15 According to an embodiment of the invention, the electrical circuit further comprises at least one sleep transistor. Each sleep transistor has analogously an emitter terminal, a collector terminal and a base terminal and is analogously configured with a bridge resistor interconnected between its emitter terminal and its base terminal and a base resistor connected to its base terminal. The at least one sleep transistor is interconnected in-between the at least one sleep input and the bi-stable sub-circuit such that the at least one sleep transistor is coupled via its base resistor to the at least one sleep input, via its emitter terminal to ground and via its collector terminal to the second connection line.

- 25 According to an embodiment of the invention, the electrical circuit implements additionally an upper voltage level check circuit. The upper voltage level check circuit comprises a second resistor, a z-diode and a fourth transistor. The fourth transistor has analogously an emitter terminal, a collector terminal and a base terminal and is analogously configured with a bridge resistor interconnected between its emitter terminal and its base terminal and a base resistor connected to its base terminal. The second resistor is coupled to a connection line between the main input and the first electrical operable switch and to a first terminal of the z-diode. The fourth transistor is coupled via its base resistor to a second terminal of the z-diode, via its emitter terminal to ground and via its collector terminal to the second connection line. And the z-diode is adapted to be conductive in case a voltage applied to the main input exceeds a pre-defined upper voltage level.

- 35 According to an embodiment of the invention, the electrical circuit further comprises a second electrical operable switch interconnected in-between the first electrical operable switch and the main output and implements additionally an lower voltage level check circuit. The lower voltage

level check circuit further comprises a third resistor, a z-diode and a fifth transistor. The fifth transistor has analogously an emitter terminal, a collector terminal and a base terminal and is analogously configured with a bridge resistor interconnected between the emitter terminal and the base terminal and a base resistor connected to its base terminal. The second resistor is coupled to a connection line between the first electrical operable switch and the main output and to a first terminal of the z-diode. The fifth transistor is coupled via its base resistor to a second terminal of the z-diode, via its emitter terminal to ground and via its collector terminal to the second electrical operable switch to be operated. And the z-diode is adapted to be conductive in case a voltage applied to the main input and conducted via the first electrical operable switch being conductive exceeds a pre-defined lower voltage level.

According to an embodiment of the invention, the first electrical operable switch is a metal-oxide field-effect transistor (MOSFET). Alternatively, the first electrical operable switch is a conventional relay.

According to an embodiment of the invention, the second electrical operable switch is a metal-oxide field-effect transistor (MOSFET). Alternatively, the second electrical operable switch is a conventional relay.

According to an embodiment of the invention, the electrical circuit further comprises a third z-diode interconnected between the second terminal of the interposed resistor and the base terminal of the second transistor within the second connection line. The z-diode is adapted to be conductive in case a voltage applied to the main input and conducted via the first transistor being conductive exceeds a pre-defined voltage level.

According to an embodiment of the invention, the motor vehicle built-in device is a free-hand installation main device for detachably connecting a mobile communication device and the external power supply is an accumulator of a motor vehicle.

According to an embodiment of the invention, a motor vehicle built-in device is provided which is operably connected to an external power supply. The motor vehicle built-in device comprises a plurality of electrical components energized by the external power supply and an electrical circuit for providing an electrical operable connection of an external power supply and the motor vehicle built-in device. The electrical circuit further implements a main input and a main output.

The main input is coupled to the external power supply, for example an accumulator of the motor vehicle including the built-in device. The main output is for example coupled internally to the components of the built-in device to be energized. The first electrical operable switch is operable

in two switching positions, an open position and a closed position. The first electrical operable switch is conductive in case it is closed and is non-conductive in case it is open. Further the electrical circuit is provided with at least one wake-up input to receive a wake-up signal and at least one sleep input to receive a sleep signal and the electrical circuit has a bi-stable sub-circuit coupled to the main input and coupled to the first electrical operable switch as well as connected to the at least one wake-up input and to the least one sleep input. The bi-stable circuit is operable such that receiving of a wake-up signal results in energizing of the bi-stable sub-circuit and receiving of a sleep signal results in de-energizing thereof. The energized bi-stable sub-circuit effects to close the first electrical operable switch and the corresponding de-energized bi-stable sub-circuit effects to open the first electrical operable switch.

According to an embodiment of the invention, electrical circuit embedded in the motor vehicle built-in device is an electrical circuit according to anyone of the aforementioned embodiments of the electrical circuit with respect to the present invention.

According to an embodiment of the invention, the motor vehicle built-in device is a free hand installation main device for detachably connecting a mobile communication device. Conventionally, such a free-hand installation is mounted permanently in a motor vehicle and provided connectivity to further installations, devices and units included in the motor vehicle. The external power supply is an accumulator of a motor vehicle.

According to an embodiment of the invention, the motor vehicle built-in device embodying a free hand installation main device at least comprises additionally an interface for exchanging signals between electrical units included in the motor vehicle and the motor vehicle built-in device, an interface for exchanging signal between the apparatus and the mobile communication device connected detachably and a control unit to pass signals in-between the interfaces. The exchanged signals comprises at least one wake-up signal and at least one sleep signal.

The invention will be described in greater detail by the means of preferred embodiments with reference to the accompanying drawings, in which

- Fig. 1 shows a block diagram illustrating a typical state of the art circuit providing connectivity of an electrical device to an external power supply;
- Fig. 2 shows a block diagram illustrating a circuit providing connectivity of an electrical device to an external power supply according to an embodiment of the invention; and
- Fig. 3 shows a block diagram illustrating a junction box of a hand-free installation according to an embodiment of the invention.



The following description relates to mobile communication devices according to embodiments of the invention. Same or equal parts shown in the figures will be referred to by the same reference numerals.

Fig. 1 illustrates a typical state of the art circuit providing connectivity of an electrical device to an external power supply. The depicted circuit is dedicated to provide connectivity of an electrical device to an external power supply, such as the accumulator of the motor vehicle, wherein the external power supply can be switched on and switched off using a switching on/off input 10 of the circuit controlling the main switch 31. A power supply input 30 is coupled to the external power supply, here a battery 35 and further the input 30 is coupled to the output 32 via the interconnected main switch 31. The output 32 provides the power to the electrical device.

A voltage regulator 10 connected to the input 30 is employed to generate a first voltage signal  $V_{wake}$  and a second voltage signal  $V_{ref}$ . The first voltage signal  $V_{wake}$  is supplied to further components of the circuit to energize them. The second voltage signal  $V_{ref}$  is used as a reference voltage signal  $V_{ref}$  to be compared with further generated voltage signals as described below.

Resistors 20, 21 and 22 connected in series and coupled to the input 30 to be energized by the external battery 35 are used as a staged voltage divider. A first test voltage is picked up in-between the resistor 20 and the resistor 21, whereas a second test voltage is picked up in-between the resistor 21 and the resistor 22. The first picked up test voltage is supplied to a first operational amplifier 11 operated as comparator to be compared with the reference voltage signal  $V_{ref}$ , whereas analogously, the second picked up test voltage is supplied to a second operational amplifier 12 operated as comparator to be compared with the reference voltage signal  $V_{ref}$ . Both the first operational amplifier 11 and the second operational amplifier 12 are energized by the first voltage signal  $V_{wake}$  generated by the voltage regulator 10.

The first operational amplifier 11 operated as comparator provides a resulting signal indicating that the operating voltage supplied to the circuit via input 30 is below a certain upper voltage level, whereas the second operational amplifier 12 operated as comparator provides a resulting signal indicating that the operating voltage supplied to the circuit via input 30 is above a certain lower voltage level.

The testing of the voltage level of the external power supply coupled to input 30 ensures that this voltage level of the external power supply is within a certain pre-defined voltage level range, defined by the characteristics of the resistors 20, 21 and 22 as well as the voltage signal  $V_{ref}$ .

generated by the voltage regulator 10. The pre-determined voltage level range is chosen to protect the mobile device, coupled to this circuit, to be energized with a voltage level being too low and with a voltage level being too high which overall results in a protection against damages and miss-operations.

5 The resulting signals of the operational amplifier 11 and 12 are supplied to inputs of a logical OR component 13. The output of the logical OR component is connected to a reset input R of a RS-flip-flop 14. That is, the RS-flip-flop 14 can only be operated via the set input S in case the voltage level of the external power supply is within the pre-determined voltage level range  
10 described above. The set input S of the RS-flip-flop serves as the switching on/off input I0 of the described circuit. In case the RS-flip-flop is in an initial mode in which the output Q of the RS-flip-flop is switched off, a pulse signal supplied to the input S switches the output Q on and a following pulse signal switches the output Q back off, i.e. to the initial mode. The output signal of the output Q of the RS-flip-flop 14 serves to operate the main switch 31 via a transistor 15.

15 The main disadvantage of the described state of the art circuit is that a couple of active components, i.e. components requiring power, consume power of the battery 35 which is the main power supply of the circuit and the device coupled to output 32. The active components, here voltage regulator 10, operational amplifiers 11 and 12, logical OR component 13 and RS-flip-flop 14, consume power even in case the device coupled to output 32 is switched off via  
20 main switch 31. Especially in case of accumulators and batteries used as main power supply coupled to input 30, the reduction of power consumption may be essential since the capacity of such power supplies is limited. Further disadvantages are the complexity of the active components and the costs of them. The complexity may result in a greater number of defects  
25 during the expected life time of the circuit which is especially in view of the high costs of the components not efficient.

The following circuit realizes the above presented features of the state of the art circuit while overcoming the disadvantages thereof.

30 Fig .2 illustrates a circuit providing connectivity of an electrical device to an external power supply according to an embodiment of the invention. The depicted circuit can be embedded in a free-hand installation providing connectivity of an electric device, e.g. mobile device, especially a mobile phone, a mobile communication handheld and further electric mobile devices, to the  
35 electronics of a motor vehicle, especially a car. Such a free-hand installation has a mechanical holder or a support for taking a mobile phone and one or several electrical contacts to couple the mobile phone to several electrical units or components of the motor vehicle, respectively, such as

a power supply, an ignition, an external antenna, a light, a data bus embedded in the motor vehicle for controlling electrical installations, an on-board multifunctional processing device, a microphone in the interior of the motor vehicle, a car radio and/or the speaker of the car radio. The free-hand installation is energized by the accumulator of the motor vehicle and is operable with a stand-by operation mode. During the stand-by operation mode the free-hand installation electronic of the motor vehicle is allowed to put the free-hand installation into operation by transmitting a dedicated wake-up signal causing to activate the functionality of the free-hand installation.

10 The depicted circuit according to an embodiment of the invention has a main input P1 and a main output P2. The main input P1 is coupled to the power supply PS, whereas the output P2 couples the depicted circuit to the electrical device to be energized by the power supply PS. The main switch Sw1 is interconnected in-between the main input P1 and the main output P2 to switch either on or off the power supplied to the main output P2 or the coupled device, respectively. At least one input I1 offers the possibility to feed in a pulse signal causing to close the main switch Sw1. Here, three inputs I1, I2 and I3 can receive pulse signals, each causing to switch on the main switch Sw1. Further at least one input Pd offers the possibility to feed in a pulse signal causing to open the main switch Sw1. An additional embedded circuit Cr1 serves to detect overvoltage and an additional embedded circuit Cr2 serves to detect lowervoltage.

20 In the following, the components of the circuit and their configuration are described in detail. The circuit is based on passive components, i.e. a plurality of configured transistors, resistors, Z-diodes and electrical operable main switches.

25 Each of the transistors comprised in the circuit is configured with resistors, i.e. a base terminal of a configured transistor has interconnected a resistor and the emitter terminal of the configured transistor is interconnected to the base via a further resistor. The configuration of the transistors is designed such that the transistors operate as electrical switches. In the following, when the transistors become conductive the conductive state will be termed as switched on, whereas when the transistor is not conductive the non-conductive state will be termed as switched off.

30 The circuit has two operation states, a power-down state and a power-up state. In the power-down state, which is also the initial circuit state, the main switch Sw1 is opened. In the power-up state the main switch Sw1 is closed, i.e. the main switch is conductive. The detailed operation of the circuit is described in the following in view of a wake-up functionality transferring the power-down state into the power-up state and a sleep functionality transferring the power-up state into the power-down state

### Wake-up functionality

5 A wake-up signal is supplied to the wake-up input I1 connected to the base terminal of the configured transistor T3 causing to switch on the configured transistor T3. The wake-up signal can be a pulse signal having a pulse level adapted to switch on the configured transistor T3. The emitter terminal of the configured transistor T3 is coupled to ground of the circuit whereas the collector terminal of the configured transistor T3 is coupled to the base terminal of the configured transistor T1, which in turn is coupled via its emitter terminal to the main input P1 and via its collector terminal through a resistor R1 to the base terminal of configured transistor T2. A configured transistor T2 switched on results in a switching on of the configured transistor T1. The configured transistor T2 is further coupled via its emitter terminal to ground and via its collector terminal to the base terminal of the configured transistor T1 such that the switched on configured transistor T1 results in a switched on transistor T2 which in turn holds the switched on status of the configured transistor T1 even in case no wake-up signal is supplied any more to the input I1.

20 The configured transistors T1 and T2 are interconnected such that a single wake-up signal supplied via the configured transistor T3 to the interconnection of the base terminal of configured transistor T1 and collector terminal of configured transistor T2 results in transition of a stable switched off status into a stable switched on status of the both configured transistors T1 and T2. The sub-circuit comprising the configured transistors T1 and T2 represents a bi-stable circuit Crbs. A signal picked up from this bi-stable circuit Crbs is used in the following to operate the main switch Sw1. In order to operate the main switch Sw1, the base terminal of the configured transistor T2 is coupled to the base terminal of a further configured transistor T5, of which the emitter terminal is connected to ground and the collector terminal operates the main switch Sw1, i.e. the main switch Sw1 is closed to be conductive. The main switch Sw1 is for example a MOS-FET (metal-oxide semiconductor field-effect transistor), a relay or any other electrical operable switch, in particular providing the possibility to pass though high currents.

30 Comprehensively, a wake-up signal supplied to wake-up input I1 switches on configured transistor T3, which in turn switches on the configured transistors T1 and T2 as well as additionally the configured transistor T5. The properties of the bi-stable sub-circuit Crbs comprising the configured transistors T1 and T2, respectively, ensures that the configured transistor T1 remains switched on and hence also the configured transistors T2 and T5 even in case the wake-up signal is no longer supplied to configured transistor T3.

The number of wake-up inputs is not limited to the aforementioned wake-up input I1. An unlimited number of wake-up inputs can be included in the presented circuit according to an embodiment of the invention. The Fig. 2 illustrates two further wake-up inputs I2 and I3. Each of the wake-up inputs have a configured transistor, here configured transistor T3a and T3b, respectively, equivalent to the configured transistor T3 and configured analogously. The configured transistor T3a and T3b are connected in parallel to the configured transistor T3, i.e. the wake-up inputs I2 and I3 are coupled to the respective base contacts of the configured transistor T3a and T3b and the collector contacts thereof are coupled to the base terminal of configured transistor T1.

### Sleep functionality

A sleep or power down signal is supplied to the sleep input Pd, respectively, connected to the base terminal of the configured transistor T4 causing to switch on the configured transistor T4. The sleep signal can be a pulse signal having a pulse level adapted to switch on the configured transistor T4. The emitter terminal of the configured transistor T4 is coupled to ground whereas the collector terminal of the configured transistor T4 is coupled to the base terminal of the configured transistor T2 and hence also to the base terminal of the configured transistor T5. The configured transistor T4 switched on causes that the both base contacts of the configured transistors T2 and T5 are tied to ground resulting in switching off of the configured transistors T2 and T5. This results further in opening of the main switch Sw1 in reaction to the configured transistor T5 switched off, i.e. transition of the power-up state of the circuit into the power-down state, and in switching off of configured transistor T1 in reaction to the configured transistor T2 switched off.

The number of sleep inputs is not limited to the aforementioned sleep input Pd. An unlimited number of sleep inputs can be included in the presented circuit according to an embodiment of the invention. The Fig. 2 illustrates only the described sleep input Pd. Further sleep inputs can be realized in that further configured transistors are connected in parallel to the configured transistor T4. These further configured transistors are equivalent to the configured transistor T4 and configured analogously. Each further configured transistor providing further sleep inputs is coupled to the base terminal of the configured transistor T2.

### Voltage Level Check

The circuit illustrated in Fig. 2 further includes sub-circuits to ensure that the voltage level of the external power supply PS is within a pre-defined voltage level range ( $V_{ZD2}$  to  $V_{ZD1}$ ). In case the

voltage level of the external power supply PS exceeds the pre-defined upper voltage level  $V_{ZD1}$  of the voltage level range a sub-circuit Cr1 protects an electrical device coupled to the output P2 by opening the main switch Sw1. In case the voltage level of the external power supply PS falls below the pre-defined lower voltage level  $V_{ZD2}$  a sub-circuit Cr2 protects an electrical device coupled to the output P2 by opening a main switch Sw2 connected in series to the main switch Sw1 and interconnected in-between main switch Sw1 and output P2.

### Upper voltage level check

The sub-circuit Cr1 comprises a configured transistor T6, a z-diode D1 and a resistor R2 both connected in series to the base terminal of the configured transistor T6, wherein the z-diode D1 is interposed between base terminal and resistor R2. In turn, the resistor R2 is further coupled to the input P1, whereas the collector terminal of the configured transistor T6 is coupled to the base terminal of configured transistor T2 and the base terminal of configured transistor T5, respectively. The z-diode D1 is interposed such that in case of the voltage level applied to the input P1 by the external power supply PS exceeds a pre-defined voltage level, this is the upper voltage level  $V_{ZD1}$ , the z-diode D1 becomes conductive and the configured transistor T6 is switched on which causes to ground the base terminal of the configured transistor T2 and the base terminal of the configured transistor T5, respectively, (in analogy to a sleep signal supplied to the sleep input Pd). The switching off of configured transistor T2 causes also to switch off the configured transistor T1. The upper voltage level  $V_{ZD1}$  is determined by the characteristics of the z-diode D1.

Once the pre-defined upper voltage level  $V_{ZD1}$  is detected to be exceeded the circuit is set into the power-down state. The circuit being again in the power-up state can be accomplished by supplying a wake-up signal to one of the implemented wake-up inputs (here, inputs I1, I2 and I3). In case of overvoltage detection the wake-up functionality is disabled.

### Lower voltage level check

The sub-circuit Cr2 comprises a configured transistor T7, a z-diode D2 and a resistor R3 both connected in series to the base terminal of the configured transistor T7, wherein the z-diode D2 is interposed between base terminal and resistor R3. In turn, the resistor R3 is further coupled to an interconnection of the main switch Sw1 and the main switch Sw2, whereas the signal of the collector terminal of the configured transistor T7 is supplied to the main switch Sw2 for operating this. The z-diode D2 is interposed such that in case of the voltage level applied to the input P1 by the external power supply PS and conducted through a closed main switch Sw2

exceeds a pre-defined voltage level, this is the lower voltage level  $V_{ZD2}$ , the z-diode D2 becomes conductive and the configured transistor T7 is switched on which causes to close the main switch Sw2 such that power is conducted from the input P1 through the main switch Sw1 and main switch Sw2 to the output P2. In case the voltage level applied to the z-diode D2 falls below the lower voltage level  $V_{ZD2}$  the configured transistor T7 is switched off and hence the main switch Sw2 is opened causing the interruption of the connection between input P1 and input P2. The lower voltage level  $V_{ZD2}$  is determined by the characteristics of the z-diode D2. The sub-circuit Cr2 operates independently from the circuit described above.

## 10 Memory functionality

The voltage level range for example is 6.5 V to 16 V, i.e. the lower voltage level  $V_{ZD2} = 6.5$  V and the upper voltage level  $V_{ZD2} = 16$  V. Further the components of the presented circuit for example are operable at a minimum voltage level of about 2 V. This means, that the main switch Sw1 is already operable with applied wake-up and sleep signals to the respective inputs in case the external power supply PS supplies a voltage level above this minimum voltage level and the main switch Sw1 can be closed. Since the lower voltage check sub-circuit Cr2 closes the main switch Sw2 only in case the voltage level of the external power supply 35 supplied to the circuit input P1 exceeds the lower voltage level  $V_{ZD2}$  no current is fed to output P2. Since further the sub-circuit Cr2 is operated independently the main switch Sw2 is closed in the moment a sufficient voltage level is supplied to input P1 by the external power supply 35. A power-up state is preserved even if the voltage level of the external power supply 35 is below the pre-defined voltage level range.

According to another embodiment of the invention, this memory effect can be prevented by interconnecting an additional z-diode in-between resistor R1 and the configured transistor T2, i.e. in-between resistor R1 and common connecting point of the configured transistors T2, T4, T5 and T6, respectively. Therefore, the additional z-diode is adapted to the lower voltage level  $V_{ZD2}$ , i.e. its characteristics are adapted to the lower voltage level  $V_{ZD2}$ , preventing the switching of the configured transistor T2 at a voltage level of the external power supply PS below the lower voltage level  $V_{ZD2}$ .

The comparison of the state of the art circuit presented in Fig. 1 and the circuit according to an embodiment of the invention presented in Fig. 2 shows clearly the aforementioned advantages of the circuit in accordance with the invention concept. In case of the power-down state of the inventive circuit shown in Fig. 2 no power is consumed by the circuit, especially when parasitic effects of the components have not to be taken into account. Even when parasitic effects are

considered a current consumption in the range of a few micro amperes is achievable. The parasitic effects can be kept under control by selecting the used and installed components. All components are passive components which have to be energized only during the power-up state of the circuit. Additionally, the functionality of the circuit is realized by a small number of single components which reduces dramatically the costs and improves the reliability of the circuit especially in view of a long life-term.

The number of wake-up inputs as well as the number of sleep inputs can be fitted easily to the respective requirements by connecting configured transistors in parallel to the corresponding configured transistors implemented therefor.

Fig. 3 illustrates a junction box of a hand-free installation according to an embodiment of the invention. The junction box at least implements a circuit according to an embodiment of the invention, for example the circuit depicted in Fig. 2. The junction box 200 provides the connectivity of a holder of a mobile device such as a mobile phone 100 depicted to an external power supply 211 and further electronic devices. Especially, wake-up and sleep signals 212 are supplied to the junction box 200. The junction box includes at least an aforementioned electric circuit 210 according to an embodiment of the invention. The power supply connection is coupled to the circuit 210 and the wake-up and sleep signals are applied to the respective inputs. The wake-up signals and/or the sleep signals can be provided via a data bus system to which one or several interfaces are coupled generating such signal in accordance with data information transmitted via the data bus. The wake-up signal can also be obtained from the holder, eg a wake-up signal is supplied to the junction box upon insertion of the mobile device into the holder.

During the stand-by operation mode of the junction box 200 the implemented electrical circuit 210 according to an embodiment of the invention causes to be operable with receiving of a wake-up signal via one of the implemented wake-up inputs while further electrical units and circuits implemented in the junction box providing the functionality of the junction box are separated from the power supply such that these further electrical units and circuits are not able to consume power of the external power supply. The wake-up inputs of the electrical circuit 210 but also the sleep inputs thereof can be adapted to different kind of wake-up and sleep signals, respectively, e.g. different signal levels, signals having a different duration of time etc.

The junction box may implement further circuits or interfaces, respectively, necessary to connect the mobile device 100 to further electric, such as an ignition, an external antenna, a light, a data bus embedded in the motor vehicle for controlling electrical installations, an on-board multifunctional processing device, a microphone in the interior of the motor vehicle, a car radio



and/or the speaker of the car radio.

5 A multi-wired cable 201 connects the junction box to a holder 110 of the mobile phone 100. The connecting cable 201 may include at least a power line coupled to the output of the circuit 210 which is energized in accordance with the wake-up and sleep signals supplied to the circuit 210. The holder 110 takes detachably the mobile phone 100, wherein the holder 110 has at least a multiple plug connector which connects holder 110 with the mobile phone 100

10 The present invention has been described in view of a hand-free installation for mobile communication device. It is to be understood that the problem which is overcome by the inventive concept also relates to a broad number of different electrical devices and the presented solutions in the way of embodiments of the electrical circuit can be implemented in these different electrical devices.

15 While the invention has been particularly shown and described with respect to embodiments as examples, it will be understood by those skilled in this area of technology that changes in form and details may be made therein, including in the form of other embodiments, without departing from the scope and spirit of the invention, which is defined by the appended claims.

## Claims

1. Electrical circuit for providing an electrically operable connection of an external power supply and an electrical device being a motor vehicle built-in device, comprising:

- a main input (P1) for coupling to said external power supply (PS);
- a main output (P2) for coupling to said electrical device; and
- a first electrical operable switch (Sw1) interconnected between said main input (P1) and said main output (P2), said first electrical operable switch (Sw1) having an open position and a closed position, said first electrical operable switch (Sw1) being conductive in said closed position and being non-conductive in said open position;

characterized in that said circuit further comprises:

- at least one wake-up input (I1, I2, I3) to receive a wake-up signal;
- at least one sleep input (Pd) to receive a sleep signal; and
- a bi-stable sub-circuit (Crbs) coupled to said main input (P1) and coupled to said first electrical operable switch (Sw1), said sub-circuit (Crbs) being connected to said at least one wake-up input (I1, I2, I3) and to said at least one sleep input (Pd) such that a received wake-up signal energizes said bi-stable sub-circuit (Crbs) and a received sleep signal de-energizes said bi-stable sub-circuit (Crbs); wherein said energized bi-stable sub-circuit (Crbs) causes to close said first electrical operable switch (Sw1) and said de-energized bi-stable sub-circuit (Crbs) causes to open said first electrical operable switch (Sw1).

2. Electrical circuit according to claim 1, characterized in that said bi-stable sub-circuit (Crbs) comprises:

- a first transistor (T1) having an emitter terminal, a collector terminal and a base terminal, wherein said first transistor (T1) is configured with a bridge resistor interconnected between its emitter terminal and its base terminal and a base resistor connected to its base terminal;
- a second transistor (T2) having an emitter terminal, a collector terminal and a base terminal, wherein said second transistor (T2) is configured with a bridge resistor interconnected between its emitter terminal and its base terminal and a base resistor connected to its base terminal; and
- an interposed resistor (R1);

wherein said first transistor (T1) is coupled via its emitter terminal to said main input (P1), via its collector terminal to a first terminal of said interposed resistor (R1) and via its base resistor to said collector terminal of said second transistor (T2); wherein said second transistor (T2) is coupled via its emitter to ground, via its base resistor to

resistor connected to its base terminal;  
 wherein said at least one sleep transistor (T4) is interconnected in-between said at least one sleep input (Pd) and said bi-stable cub-circuit (Crbs) such that said at least one sleep transistor (T4) is coupled via its base resistor to said at least one sleep input (Pd), via its emitter terminal to ground and via its collector terminal to said second connection line.

6. Electrical circuit according to anyone of the claims 2 to 5, characterized by

- an upper voltage level check circuit (Cr1) comprising:

- a second resistor (R2);
- a z-diode (D1); and
- a fourth transistor (T6) having an emitter terminal, a collector terminal and a base terminal, wherein said fourth transistor (T6) is configured with a bridge resistor interconnected between its emitter terminal and its base terminal and a base resistor connected to its base terminal;

wherein said second resistor (R2) is coupled to a connection line between said main input (P1) and said first electrical operable switch (Sw1) and to a first terminal of said z-diode (D1);

wherein said fourth transistor (T6) is coupled via its base resistor to a second terminal of said z-diode (D1), via its emitter terminal to ground and via its collector terminal to said second connection line; and

wherein said z-diode is adapted to be conductive in case a voltage applied to said main input (P1) exceeds a pre-defined upper voltage level ( $V_{ZD1}$ ).

7. Electrical circuit according to anyone of the claims 2 to 6, characterized by

- a second electrical operable switch (Sw2) interconnected in-between said first electrical operable switch (Sw1) and said main output (P2); and
- an lower voltage level check circuit (Cr2) comprising

- a third resistor (R3);
- a z-diode (D2); and

- a fifth transistor (T7) having an emitter terminal, a collector terminal and a base terminal, wherein said fifth transistor (T7) is configured with a bridge resistor interconnected between said emitter terminal and said base terminal and a base resistor connected to its base terminal;

wherein said second resistor (R3) is coupled to a connection line between said first electrical operable switch (Sw1) and said main output (P2) and to a first terminal of said z-diode (D2);

wherein said fifth transistor (T7) is coupled via its base resistor to a second terminal of said z-diode (D2), via its emitter terminal to ground and via its collector terminal to said second

electrical operable switch (Sw2) to be operated; and  
 wherein said z-diode (D2) is adapted to be conductive in case a voltage applied to said main input (P1) and conducted via said first electrical operable switch (Sw1) being conductive exceeds a pre-defined lower voltage level ( $V_{ZD2}$ ).

8. Electrical circuit according to claim anyone of the preceding claims, characterized in that said first electrical operable switch (Sw1) is a metal-oxide field-effect transistor (MOSFET).

9. Electrical circuit according to claim 7 or claim 8, characterized in that said second electrical operable switch (Sw1) is a metal-oxide field-effect transistor (MOSFET).

10. Electrical circuit according to anyone of the claims 2 to 9, characterized by

- a third z-diode interconnected between said second terminal of said interposed resistor (R1) and said base terminal of said second transistor (T2) within said second connection line;

wherein said z-diode is adapted to be conductive in case a voltage applied to said main input (P1) and conducted via said first transistor (T1) being conductive exceeds a pre-defined voltage level.

11. Electrical circuit according to anyone of the preceding claims, wherein said motor vehicle built-in device is a free-hand installation main device (200) for detachably connecting a mobile communication device (100) and said external power supply (PS) is an accumulator of a motor vehicle.

12. Motor vehicle built-in device being operably connected to an external power supply, comprising:

- a plurality of electrical components energized by said external power supply; and
- an electrical circuit (210) for providing an electrical operable connection of an external power supply and said motor vehicle built-in device,

characterized in that said electrical circuit (210) comprises:

- a main input (P1) for coupling to said external power supply (PS);
- a main output (P2) for coupling to said motor vehicle built-in device;
- a first electrical operable switch (Sw1) interconnected between said main input (P1) and said main output (P2), said first electrical operable switch (Sw1) having an open position and a closed position, said first electrical operable switch (Sw1) being conductive in said closed position and being non-conductive in said open position;
- at least one wake-up input (I1, I2, I3) to receive a wake-up signal;

- at least one sleep input (Pd) to receive a sleep signal; and
  - a bi-stable sub-circuit (Crbs) coupled to said main input (P1) and coupled to said first electrical operable switch (Sw1), said sub-circuit (Crbs) being connected to said at least one wake-up input (I1, I2, I3) and to said at least one sleep input (Pd) such that
- 5 a received wake-up signal energizes said bi-stable sub-circuit (Crbs) and a received sleep signal de-energizes said bi-stable sub-circuit (Crbs); wherein said energized bi-stable sub-circuit (Crbs) causes to close said first electrical operable switch (Sw1) and said de-energized bi-stable sub-circuit (Crbs) causes to open said first electrical operable switch (Sw1).

10 13. Motor vehicle built-in device according to claim 12, characterized in that said electrical circuit (210) is an electrical circuit (210) according to anyone of the claims 1 to 10.

15 14. Motor vehicle built-in device according to claim 12 or claim 13, characterized in that said motor vehicle built-in device (200) is a free hand installation main device (200) for detachably connecting a mobile communication device (100) and said external power supply is an accumulator of a motor vehicle.

20 15. Motor vehicle built-in device according to claim 14, further comprising:

- at least one interface for exchanging signals (211, 212, 205) between electrical units included in said motor vehicle and said motor vehicle built-in device (200), said signals (211, 212, 205) comprising said at least one wake-up signal and said at least one sleep signal;
- at least one interface for exchanging signal (201) between said motor vehicle built-in device (200) and said mobile communication device (100) connected detachably (105);
- 25 and
- at least one control unit to pass signals in-between said interfaces.

**Abstract**

5 The number of electrical devices implemented in motor vehicles and supplied with electricity by the motor vehicle accumulator rises with each generation. The manufacturers of motor vehicles make great demands on electrical device to be built-in their motor vehicles, especially to the stand-by power consumption of the built-in devices in order to protect the motor vehicle accumulator from a fast and undesired unloading during the stop of the motor vehicle.

10 The present invention relates to an electrical circuit provided to be implemented in motor vehicle built-in devices for limiting the power consumption during the stand-by thereof, i.e. to reduce the power consumption to almost no consumption. Further, the present invention relates to an electrical motor vehicle built-in device having the aforementioned electrical circuit for limiting the power consumption of the electrical motor vehicle built-in device.

15 (Fig. 2)

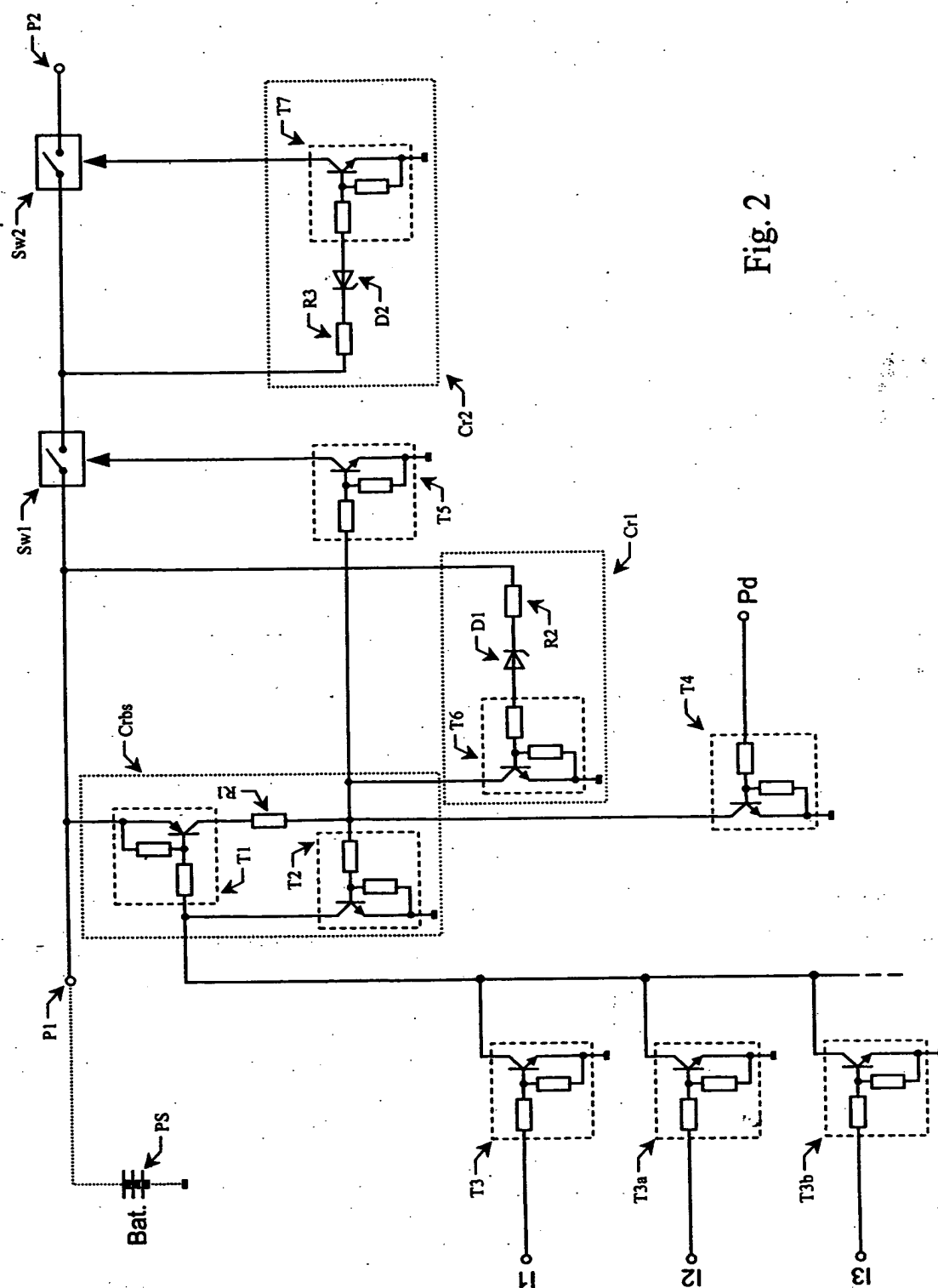


Fig. 2

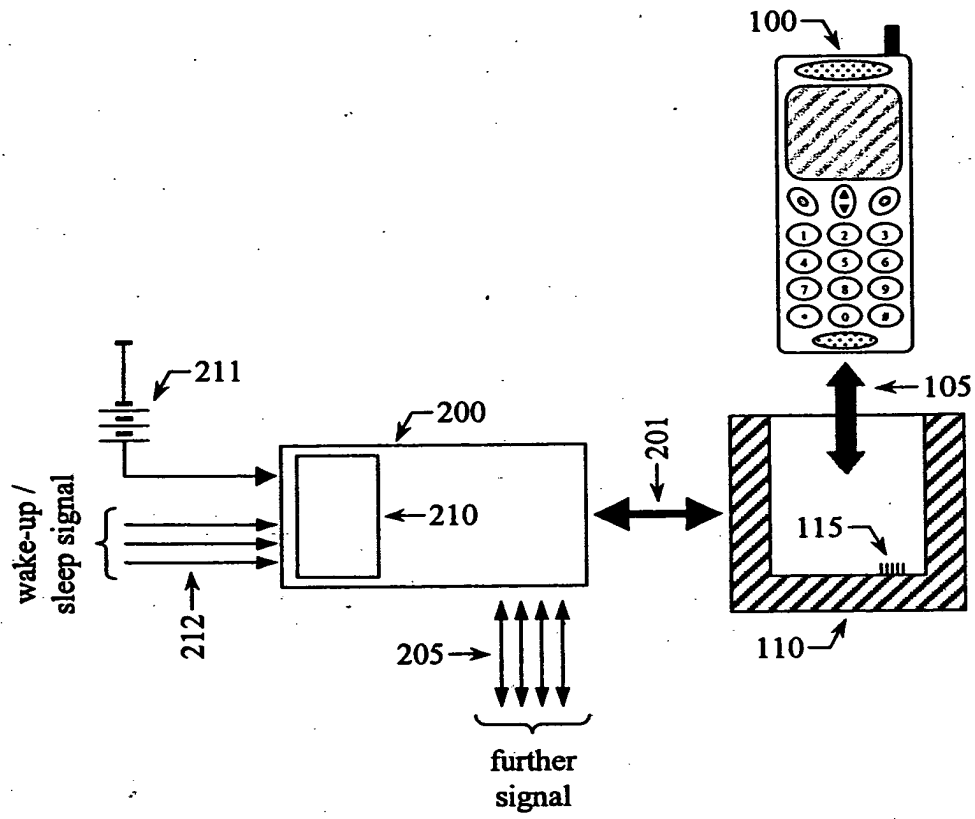


Fig. 3